Comparison of preterm infant pain tools: the PIPP and the NFCS

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Master of Science in Nursing

Comparison of Preterm Infant Pain Tools: The PIPP and the NFCS

Submitted by

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In partial fulfillment of the requirements for the degree of Master of Science in Nursing.

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Joel Simmons
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CHAPTER I

Introduction

Infants born prematurely exit the comforting and desirable intrauterine environment, and are often abruptly transferred to the much more cold and demanding environment known as the neonatal intensive care unit (NICU). It is in this new environment where multiple procedures begin which can be described as uncomfortable at best, and at worst painful. Many of these procedures which are performed on the neonate are major advances in neonatal care which will enable a much higher proportion of preterm infants to survive. However, these invasive procedures, although necessary, do affect the neonate both physically and behaviorally.

When a procedure is performed on a neonate, the infant responds both physiologically and behaviorally. These physical and behavioral responses are the cues for detecting a neonate’s pain and/or distress to these invasive procedures. Because the infant has limited energy reserves, accurate interpretation of preterm infant pain behaviors are crucial (Holsti, Grunau, Oberlander, & Whitfield, 2004). Consequently, identifying and treating pain in preterm infants is a high priority for caregivers in the NICU.
Research now suggests that early pain exposure may alter nociceptive pathways and may also contribute to changes in other areas of development (Holsti et al., 2004). Furthermore, multiple lines of evidence now suggest that early repeated and prolonged pain exposure may contribute to altered development of pain systems, behavior, cognition, and learning in former preterm infants later in childhood (Grunau, Weinberg, & Whitfield, 2004). This observation has raised intriguing questions about the role of early adverse experiences which may be influencing neurological development, and concerns regarding the effects of the care provided in the NICU (Grunau et al., 2004).

In addition to these findings, preterm neonates seem to have a lower pain threshold than term infants (Oberlander et al., 2000). This altered excitability spreads to multiple levels of the spinal cord and may cause non-noxious stimuli (handling, physical examination, and other nursing procedures) to be perceived as noxious stimuli and stimulate the systemic physiologic responses to stress. This leads to long-term responses to tissue injury that outlasts the initial noxious stimulus, leading to chronic noxious stimulation (Oberlander et al., 2000).

For these reasons, prevention of painful stimuli needs to be prevented or minimized as much as possible.
However, accurate identification of pain responses in the neonate is complex for a number of reasons. First, preterm infants respond with facial, motor, and physiologic changes to acute pain, but they differ from term infants in that their responses are of smaller magnitude, particularly at younger gestational ages (Holsti et al., 2004). Second, preterm infants at earlier gestational ages may display different pain behaviors than infants at later gestational ages as a result of neurologic immaturity (Holsti et al., 2004). Such behaviors may not be captured in the current pain scales because the behaviors chosen have been based on behaviors seen in term infants (Holsti et al., 2004). Third, no physiologic or behavioral threshold specifically marks the presence of pain (Holsti et al., 2004). Finally, although using a single pain index is easier for clinicians, the physiologic and behavioral responses of preterm infants to painful stimuli are often dissociated; therefore, reliance on current pain indices may not capture the range of responses in this population (Holsti et al., 2004).

Despite the complexities and difficulties the clinician faces when assessing the neonate’s pain, the Joint Commission on Accreditation of Health Care Organizations now requires healthcare providers to assess and treat pain in neonates (Joint Commission on Accreditation of Healthcare Organizations, 2002). This mandate arose from research which showed that the neonate
does perceive pain (Lindh et al., 1987; Johnston et al., 1995; Brooks, 1999; Glover et al., 2000; Puchalski et al., 2002; Evans, 2002). For example, Glover and Fisk (2000) noted that the full anatomical pathways necessary for nociception are in place at 24-28 weeks gestation. This and other research now suggests that for years, neonates and full term infants were put through numerous painful procedures under the belief that they were unable to perceive pain (Abu-Saad et al., 1998). Today, we now know this is not true.

With the new understanding of nociception in the neonate came the development of tools for assessing their pain. However, as stated previously, a most critical challenge for effective pain management in neonates is the difficulty of accurate assessment of the infant’s pain. Pain is highly subjective, and in neonates, it is complicated by the inadequacy of the infant to effectively communicate pain. Furthermore, the infant responds to pain both physiologically and behaviorally with great variability from neonate to neonate (Abu-Saad, 1998).

Multiple tools for assessing pain in preterm infants have been published and are considered reliable and valid. These tools include, The Neonatal Facial Coding System (NFCS) (Grunau & Craig, 1987), the Newborn Infant Pain Scale (NIPS) (Lawrence et al., 1993), the Behavioral Pain Scale (BPS) (Pokela, 1994), the Distress Scale for Ventilated Infants (DSVNI) (Sparshott,
1996), the CRIES (Krechel & Bildner, 1995), the Scale for Use in Newborns (SUN) (Blauer & Gerstmann, 1998), the Neonatal Pain Assessment Tool (NPAT) (Friedrichs et al., 1995), the Pain Assessment Tool (PAT) (Hodgkinson et al., 1994), the Fuller Infant Pain Assessment Tool (FIPA) (Fuller & Neu, 2000), and the Comfort Scale (Ambuel et al., 1992).

Statement of the Problem

From a clinical standpoint, pain assessment tools have been beneficial in evaluating a neonate’s pain. However, these same tools have also failed practitioners in that there is no consistency from one tool to the next (Abu-Saad, 1998). Clinicians have been left to guess how one scale correlates to the next. Many of the tools were developed for research purposes and are not appropriate for use in clinical practice (Abu-Saad, 1998).

Because of the new mandate to measure and monitor the neonate’s pain, these pain tools have made their way into the clinical setting. This has left the clinician to choose between these differing scales without the research which gives the clinician the ability to equivalently compare the reliability and sensitivity of one scale to the next. In fact, very little research has been done comparing the various neonate pain assessment tools. Only four studies have compared two or more
assessment tools for procedural pain in preterm infants (Blauer and Gertsmann; Guinsgerg et al.; Patel et al.; Sizun et al.).

Statement of the Purpose

The purpose of this study is to determine the correlation between pain scale scores on the Neonatal Facial Coding System (NFCS) with scores on the Premature Infant Pain Profile (PIPP).

Nursing Conceptual/Theoretical Framework

The conceptual foundation for this study is based on Levine’s Model of Energy Conservation. To survive in the extrauterine environment, preterm infants must adapt to numerous challenges which term infants are not subject to when born at term (Mefford, 2004). The infant accomplishes this by constantly making adjustments with the environment and those individuals within the infant’s environment who interact with that infant.

Levine’s model for the conservation of energy is centered on maintaining a balanced state, or maintaining homeostasis. In Levine’s conservation model, the goal of the nurse is the conservation of the whole individual or client (Levine, 1966). This includes energy conservation within the infant’s internal environment (physiologic processes) and energy conservation with the external environment which consists of perceptual, operational and conceptual components (Levine, 1969).
Levine described the ideal state as a state of “wholeness” (Levine, 1989). This is the state when the interaction between the internal and external environment is described as having the “best fit” (Levine, 1989). Whenever a disruption occurs between this internal and external interface (also known as a disruption in homeostasis), the neonate may experience a disruption in health. An organism, or in this case, the premature neonate, survives by adapting both internally and externally with responses that consume the least amount of energy. However, as discussed above, because the neonate is subjected to numerous procedures, many which are performed routinely, the ability of the neonate to conserve energy can be lost (Mefford, 2004). Should this cycle continue to occur, the loss of energy will eventually exceed the ability to conserve or gain energy. The end result is a neonate who is more prone to diminished health or even illness simply as a result of the interactions that have occurred between the neonate and its environment (Mefford, 2004).

To restore health, the nurse implements therapeutic and supportive nursing interventions in accordance with the principles of Levine’s conservation principles within the nursing context. These principles are conservation of energy, structural integrity, personal integrity, and social integrity (Mefford, 2004, Levine, 1973).
Within the context of conserving the neonate’s energy to promote its wellness, the necessity for a correlation amongst the pain assessment tools becomes readily apparent. These tools are the best means for clinicians to assess and identify the infant’s pain. When these tools are correlated and their significance is determined, the clinician will be better equipped for choosing the best scale for detecting distress and/or pain in the infant. This will allow the clinician to take the appropriate therapeutic action which will result in the neonate conserving its energy and promoting its health or wholeness.

Research Questions

1.) Does a correlation exist between two pain measures, the Premature Infant Pain Profile (PIPP) and the Neonatal Facial Coding System (NFCS).

2.) What is the range of scores on the NFCS and PIPP when heelsticks are performed?

Definition of Terms

Pain - Conceptual Definition

The International Association for the Study of Pain defines pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (Merskey & Bogduk, 1994). In the preterm infant pain is a combination of physiologic/autonomic
and/or a behavioral response to a tissue-injuring stimulus (Johnston, Stevens, Yang & Horton, 1995). The physiologic responses include increases in heart rate, respiratory rate, blood pressure, palmar sweating, intracranial pressure, and cortisol levels. Conversely, there are physiologic decreases in vagal tone, pO$_2$ levels, and transcutaneous oxygen saturation levels (Stevens, Johnston, & Grunau, 1995). Behavioral responses include facial expressions, cry (frequency, peak, duration, and latency), and body movements (Stevens et al., 1995).

**Pain - Operational Definition**

For this study, pain was coded using The Neonatal Facial Coding System (NFCS) (Grunau & Craig, 1990). When scoring infant pain with the NFCS, scores range from 0 (no pain) to 10 (maximum pain). In the original study by Evans et al. (2002) the infants were scored using The Premature Infant Pain Profile (PIPP) (Stevens, Johnston, Petryshen, & Taddio, 1996). Each indicator in the PIPP tool is scored on a 4-point scale (score of 0 to 3). Younger infants can reach a score of 21, while older infants can score a maximum of 18. For all age groups, a total score of 6 or less generally indicates minimal or no pain; a score of 7 to 12 indicates mild pain; a score greater than 12 suggests moderate to severe pain (Stevens et al., 1996)
Scores from the original study, using the PIPP, along with scores from this study, using the NFCS, were entered into a database. Correlation statistics were run to determine the correlation between these two tools for coding infant pain.

**Preterm Infant – Conceptual Definition**

The preterm infant is a neonate born before the completion of 37 weeks (259 days) of gestation (Davis, 1993).

**Preterm Infant – Operational Definition**

For this study the preterm infant included neonates who ranged from 24 to 35 gestational weeks.

**Significance**

In years past, clinicians questioned whether or not premature infants were capable of feeling pain. This question was based on the uncertainty of the stages of neurological development in the neonate (Jorgensen, 1999) and the belief in the absence of pain receptors and the lack of myelination of the peripheral nerves (Abu-Saad, Bours, Stevens, & Hamers, 1998). We now know this is not the case. Multiple studies have been conducted which demonstrated the ability of the premature infant to feel pain (Lindh et al., 1987; Johnston et al., 1995; Brooks, 1999; Glover et al., 2000; Puchalski et al., 2002; Evans, 2002). With this knowledge came the development of multiple pain assessment tools for the premature and term infant. However, there currently is not an easily administered, widely accepted,
uniform technique for assessing pain in the neonate (Frank, Smith Greenberg, & Stevens, 2000).

Furthermore, there is little research which compares the assessment tools against each other. As a result, this study was designed to evaluate the correlation between the PIPP and the NFCS pain tools. This will benefit the clinician with additional tools for assessing pain. The ultimate significance will be to the neonate who will benefit with earlier detection followed by the necessary steps by the clinician to alleviate the infant’s pain.

**Hypothesis**

The PIPP and the NFCS have been previously established as valid tools for assessing the premature infant’s pain (Grunau & Craig, 1987; Stevens et al., 1996; Ballantyne et al., 1999; Abu-Saad et al., 1999; Duhn & Medves, 2004). Therefore, a positive correlation is expected between the PIPP (a multidimensional tool) and the NFCS (a unidimensional tool).

**Assumptions**

This study assumed that premature neonates felt pain, and the observed physiologic and behavioral responses which were coded with the pain assessment tools were responses to that perceived pain. The heelstick was a painful action which did elicit the physiological nociception pathways by way of tissue damage. Finally, it was assumed that all heelsticks were
performed in like manner to eliminate as much variability in the technique as possible.

Limitations

This study consisted of a Convenience sample (n=20). This sample size was small and does limit the generalization of the study to the population. Secondly, the use of the videotape limited the visibility for coding the infant’s response to the heelstick. As a result of this limited view, inaccurate coding may have resulted. Finally, the duration the heelsticks were coded was not equal. Each tape was viewed for approximately two to three minutes. It is conceivable that a response to the heelstick may have occurred after the videotape was stopped thus resulting in inaccurate results.

Summary

The premature neonate enters an environment which immediately subjects this infant to a multitude of invasive medical procedures. These procedures and the environment in which they are performed subject these tiny beings to numerous painful stimuli. As a result, the infant must constantly struggle to conserve its energy so that it can continue the growth that was intended to occur during intrauterine life. Because the neonate is not able to easily communicate its discomfort, tools which assess for signs and symptoms of pain must be used. However, because there are multiple pain tools,
and none which is unanimously preferred, it is imperative to compare the tools against each other to aid the clinician in the best choice of tool. Not only will this benefit the clinician in providing more effective care, but the neonate stands to benefit the most as the clinician can take the necessary steps to alleviate the infant’s pain. This will result in energy conservation which leads to the promotion of the infant’s wholeness.
CHAPTER II

Literature Review

This chapter provides a discussion of the conceptual framework for the study, including a schematic model, a discussion of the physiology of pain and the physiologic and behavior response initiated by the premature neonate to that painful stimulus. In addition, a discussion of the two pain tools utilized for this study, the PIPP and the NFCS, are considered.

Conceptual Framework

*Levine’s Model of Energy Conservation*

The conceptual framework for this study was based on Myra Levine’s Model of Energy Conservation (Levine, 1969, 1989). Levine described the individual components which contribute to the complete system. The inter-relatedness of the components of the system is a complex network, but each component is a state of adjustment to maintain or conserve energy of the whole being (Levine, 1973, 1989). The internal environment consists of all the physiological processes the human body performs to maintain homeostasis and conserve energy. Internal physiological adjustments in heart rate, blood pressure and oxygen saturation are examples of physiologic mechanisms that are constantly
altered within an ideal narrow range to maintain homeostasis (Mefford, 2004).

Measurements of these physiologic components are useful for interpreting the effects of stimuli on the infant. These and other physiologic measurements are used for assessment for some of the existing pain tools, including the PIPP.

In addition to this internal network, the infant is also in constant interaction with its environment and can not be viewed apart from the environment in which it inhabits (Levine, 1973).

Levine described a “wholeness” (1973, 1989, 1996) when the infant and its internal environment exist in a “smooth interface” (1989). Any disruption between the internal and external environments poses an “environmental challenge” (Levine, 1989) which can lead to a disruption in health for the neonate.

Should this disruption occur, the nurse then responds to restore health in accordance with the conservation principles of nursing (conservation of energy, structural integrity, personal integrity, and social integrity) (Levine, 1989; Mefford, 2004). Because the infant can not remove itself from its surroundings, the environment in which it lives becomes a vital part of its existence (Levine, 1989). As a result, Levine’s theory demonstrates that the integrity of the premature neonate’s
internal environment is greatly affected by its external environment, typically the NICU.

Levine stated (1969) that the background of environmental information is incessant and every kind of stimulus impinges upon the individual at once. Sight, sound, odor, temperature, posture in relation to gravity and body position – all the information that is necessary in order to orient the individual – he unceasingly receives (Levine, 1969; Mefford, 2004). The infant in the NICU is constantly stimulated from numerous stimuli in its surroundings. The infant’s sensory system can easily become overwhelmed because the premature infant does not have the mature sensory system or nervous system to effectively process these multiple stimuli (Mefford, 2004). Levine (1973) describes three components that make up the external environment; the perceptual, operational, and conceptual environment.

The perceptual environment is the part of the environment which is detected by the neonate’s senses (Levine, 1973). Stimuli from this environment include lights, noise, people, temperature, touch, taste, smell, balance, and equipment.

The operational environment refers to environmental components to which the individual responds using mechanisms other than the senses (Levine, 1973). Examples of the operational environment include microorganisms, gravity,
pollutants, and radiation (Levine, 1973). Much of the operational environment is potentially harmful to the preterm infant (Mefford, 2004). While still intrauterine, the neonate is protected from the elements of the operational environment. However, once the neonate enters the operational environment, its affects can begin to harm the preterm neonate because this infant does not yet have a well developed integumentary and/or immune system to buffer the harmful effects of these elements of this portion of the environment (Mefford, 2004).

Finally, the last component of the external environment described by Levine (1973) is the conceptual environment which includes the cognitive, emotional, psychological, and spiritual experiences of life. The ability of the premature infant to perform conceptual skills depends upon the adequate development of a functioning central nervous system (Mefford, 2004). Preterm infants exhibit varying degrees of neurodevelopment. As a result, the premature infant is often not able to interact with the conceptual environment due to this lack of neurodevelopment (Mefford, 2004). Unfortunately, the multiple stimuli from the conceptual environment are still present. In order to survive, the newborn must rapidly begin to adapt to these stimulations. The earlier the gestational age, the less competent the CNS is, and the more difficult the learning challenges will be for the premature infant (Mefford, 2004).
Whether the stimulus is from the perceptual, operational, or conceptual environment is not the issue. What matters most is that the premature infant is not yet equipped developmentally to adapt to these multiple and often constant stimuli that the environment of the NICU forces this infant to integrate. Levine described adaptation as “the process by which individuals ‘fit’ within the environment in which they live” (Levine, 1989; Mefford, 2004). The result can be an overload on the internal system of the infant leading to an over expenditure of energy which leads to fatigue and finally to a compromised health state. An awareness of these categories of the environment demonstrates the need to minimize the stimuli directed at the premature infant from each of these components of the environment. In doing so, the potential harmful effects are reduced and the well-being of the premature infant is promoted (Mefford, 2004).

The principles presented by the Levine Model of Energy Conservation as it applies to this study are presented in the schematic diagram on the following page.

*Physiology of Pain in the Preterm Infant*

When a challenge is encountered in the external environment, the preterm infant must be able to stabilize its internal environment in order to conserve energy, maintain homeostasis, and remain healthy (Levine, 1973, 1989, 1991).
Figure 1. Schematic Map: Levine’s Energy Conservation Model for the Neonatal Infant

Levine’s Conservation Principles

Adaptation

Energy Conservation

Internal Environment

Wholeness

Physical/Behavioral Response
(Video Observation)

Neonate

Nursing Care
(Intravenous)
Heel Stick

Causes

FIPP Scale
(Multidimensional)

Behavioral:  Bow
Blink, Eye Squeeze,
and Naso-Labial
Furrow.

Physiological:  Heart
Rate, Oxygen
Saturation,

Contextual:  Gestational
Age and Behavioral
State

NFCS Scale
(Unidimensional)

Behavioral:  Bow
Blink, Eye Squeeze,
Naso-Labial Furrow,
Open Lip, Horizontal
Mouth Suck, Vertical
Mouth Suck, Lip
Purse, Tongue
Tongue Protrusion, and
Chin Quiver
Levine described this adaptation as “the process by which individuals ‘fit’ the environments in which they live” (Levine, 1989, 1996) with the CNS performing the critical integrating function that allows a unified adaptive response (Levine, 1966, 1969). The preterm infant attempts to generate an integrated adaptive response to fit the extrauterine environment, however, the generalized immaturity of the organ systems, especially the CNS, makes adaptation quite difficult (Als, 1986; Barb & Lemons, 1989; (White-Traut, Nelson, Burns, & Cunningham, 1994).

Adaptation is the process by which the premature infant responds to the multitude of challenges it encounters within the extrauterine environment (Levine, 1991). Adaptation promotes integrity and wellness and consists of both physiological and behavioral responses to conditions encountered in the environment. Adaptation can be a response to pain that serves to protect the neonate. However, constant or repetitive pain can certainly cause harm and deplete the energy reserve (Levine, 1969, 1989).

The pain experience is composed of three different components; a sensory discriminative component that characterizes the painful stimulus in terms of intensity, location, and duration; an affective-motivational component that is associated with complex behavioral attributes, emotional responses, such as anxiety, and a “need state” to limit the
duration and intensity of the painful stimuli; and a cognitive-
interpretational component that relates the painful experience
to its environmental context and biophysical significance which
compares it to similar previous experiences (Anand, 1999).

There is a great amount of overlap between each of the
three components of the pain experience. Coupling mechanisms in
the immature brain are quite different from those of the fully
developed brain. This suggests that findings from older
subjects can not be compared to infants and children (Anand,
1999). Sensory stimulation of the young infant often produces a
variety of responses, and at times, no physical response to pain
is observed. This can likely be explained by immature patterns
of supraspinal processing in the newborn, poor stimulus response
coupling, and a lack of somatic localization. This likely
reflects the immaturity of neuroanatomical elements and
neurochemical mechanisms (Anand, 1999).

The peripheral nervous system and the central nervous
system are both actively involved in the transmission and
recognition of pain. A-delta fibers and C-polymodal fibers are
responsible for the transmission of pain (Jorgensen, 1999). The
A-delta fibers are encapsulated with myelin, and therefore
rapidly conduct the perception of the pain stimuli. This is the
"first pain" (Stevens et al., 1996; Jorgensen, 1999) that is
associated with pain perception. The C-polymodal fibers are
unmyelinated, and therefore conduct the same painful stimuli much more slowly. This “second pain” (Stevens et al., 1996; Jorgensen, 1999) is associated with an aching and/or burning sensation. Both types of nerve fibers transmit the pain stimuli to the dorsal horn of the spinal cord (Jorgensen, 1999). The central nervous system then processes this sensory information in the cerebral cortex of the brain (Porth, 2002). From here a response is initiated and a memory of the painful experience is formed (Jorgensen, 1999).

Fitzgerald (1995) stated that repeated stimuli in the neonate results in hyperinnervation, with the sprouting of both A and C pain fibers. The author attributed this phenomenon of hypersensitivity to the plasticity of the nervous system in the very young infant and to the effects of pain on sensory fibers during a critical phase of neurological development. In fact, prolonged hypersensitivity even decreases the pain threshold to the point that the preterm infant may perceive normally non-noxious stimuli such as routine handling as painful (Evans, Vogelpohl, Bourguignon, & Morcott, 1997).

The endocrine system is also involved in the perception of pain (Jorgensen, 1999). Hormones (neurotransmitters) are either released or inhibited in response to neuronal stimulation. Neurotransmitters enhance the transmission of impulses across the synaptic clefts from one neuron to the next. The
neurotransmitters include epinephrine, norepinephrine, dopamine, and acetylcholine. The counterpart to these activating hormones are endorphins which are the hormones which bind to opiate receptor sites in the brain and spinal cord, blocking the release of the excitatory neurotransmitters (Jorgensen). Therefore, alteration in neurologic function or endocrine function can alter the perception of pain, and therefore the reaction to painful stimuli (Jorgensen, 1999). The result can be either a hypersensitivity or hyposensitivity to painful stimuli (Jorgensen, 1999). This is evident by the observation that preterm infants lack the neurotransmitters dopamine and norepinephrine (Evans, 2001). This limits the ability of the infant to modulate pain and results in an increased intensity to the pain stimuli (Evans, 2001).

Finally, the effects of the repeated painful stimulations associated with the procedures of the NICU result in several behavioral, hormonal, and physiological changes (Jorgensen, 1999). Many of the traditional signs and symptoms of pain are altered or absent because of the infants gestational age, severity of illness, and general condition (Jorgensen, 1999). The well integrated infant responds to noxious and painful stimuli energetically; the preterm infant withdraws or shuts down appearing to be asleep (Jorgensen, 1999).
Pain alters physiologic parameters such as heart rate, respiratory rate and pattern, blood pressure, oxygen saturation, and intracranial pressure (Jorgensen, 1999; Stevens, Johnston, & Horton, 1993). The less robust premature infant may be bradycardic and apneic with resulting hypoxia which will produce pallor and/or cyanosis (Jorgensen, 1999). Palmar sweating and dilated pupils in the full term infant also suggest pain (Jorgensen, 1999).

Behavioral characteristics which are suggestive of pain have been shown to include brow bulge, eye squeeze, naso-labial furrow, open lips, crying, stretched mouth, and a quivering chin (Jorgensen, 1999; Stevens et al., 1993). The infant who is intubated may exhibit these same signs but with a “silent cry” (Jorgensen, 1999). In addition, muscle tone changes in response to pain. For the robust infant, muscle tone increases in response to painful stimuli. This infant may show vigorous movements, extend and flex arms and legs, and squirm in bed. Conversely, the less robust premature infant may appear more flaccid lying more quietly in bed (Jorgensen). This does not indicate that this infant is not in pain or distress, but that it is incapable to mount a behavioral or physiologic response (Jorgensen, 1999).

Finally, hormonal changes also occur in response to painful stimuli in the premature neonate. These changes include
increased levels of circulating stress hormones such as cortisol, prostaglandins, cytokines, nerve growth factor, and catecholamines which are accepted as markers of a painful response (Jorgensen, 1999). These increased circulating stress hormones contribute to the decreased wound healing and growth pattern observed in the premature neonate. This also contributes to the further complications and increased length of stay in the NICU (Jorgensen, 1999).

Researchers are investigating the long-term effects of neonatal pain. Glover and Fisk (2000) described evidence to suggest that early painful or stressful experiences can have long-term effects. They also suggested that tissue damage in the early neonatal period causes hyperinnervation to that area that can last into adulthood (Glover and Fisk, 2000). Merskey (1994) suggests that repeated tissue damage may extend into adjacent uninjured tissue and cause pain sensations (alldynia) from stimuli that normally would not invoke a pain response. Puchalski and Hummel (2002) found that over-stimulation of one pathway (e.g. the nociceptive pathway) can lead to under-stimulation and underdevelopment of another pathway (e.g. the non-pain pathway). Anand (1999) hypothesized that the plasticity of the developing pain system in neonates provides a critical window for producing long-term changes in subsequent behavior, responses to stress, and susceptibility to
psychosomatic complaints and psychiatric disorders in later life. Stevens, Johnston, and Grunau (1995) noted that the structures needed for the long-term memory are well developed in the newborn period; therefore, painful experiences during that period have the potential to affect long-term outcomes.

It is also suggested that although pain may not specifically be remembered, stress related to the event may mediate altered responses later in life (Stevens, Johnston, and Grunau, 1995).

It is hopeful that research in this area will lead to a more widespread understanding and acceptance of the reality of neonatal pain. This will hopefully lead clinicians to take the necessary measures for reducing pain in this vulnerable population.

Review of the Pain Tools: the PIPP and the NFCS

When choosing a pain scale, the following three factors should be considered: validity, reliability, and clinical usefulness (Hummel & Puchalski, 2001; Stevens et al., 1995). First, is the scale valid—does it measure pain? A tool is considered valid if it measures what it reports to measure. Pain measures ideally should include only those indicators that are specific or unique to pain. Physiologic outcomes alone are not specific to pain because they are part of the body’s nonspecific response to stress (Stevens et al., 1995). Other
outcomes, such as facial actions that comprise the grimace, may be more specific to pain (Stevens et al., 1995).

Content validity is established if a score increases with a known pain situation. Also, validity can be established by using a scale concomitantly with another scale for comparison (Hummel & Puchalski, 2001; Stevens et al., 1995). Validity is established when the increase and decrease of scores is similar (Hummel & Puchalski, 2001). However, validity is difficult to establish for pain measures because of the multidimensionality of the pain phenomenon and the lack of a gold standard for the quantification of pain perception in neonates (Blauer & Gerstmann, 1998; Hummel & Puchalski, 2001; Stevens et al., 1995).

Second, pain tools must be reliable (Hummel & Puchalski, 2001; Stevens et al., 1995). Reliability is established when pain ratings are consistent. Reliability refers to inter-rater reliability: when two clinicians look at the baby at the same time, and the scores are very similar. If the two clinicians give widely different scores using the same tool, the tool would not be reliable (Hummel & Puchalski, 2001; Stevens et al., 1995).

Third, the tool should be feasible or clinically practical (Hummel & Puchalski, 2001; Stevens et al., 1995). It is possible the tool was designed for research. However, clinical
usefulness of the tool is of primary importance to the bedside clinician (Hummel & Puchalski, 2001). If the tool is time consuming or difficult to administer, it may not be feasible to use as often as its design intended, and the accuracy of use may be affected (Stevens et al., 1995)

**Neonatal Facial Coding System (NFCS)**

Pain assessment tools fall into one of two categories. They are either unidimensional or multidimensional measures. Unidimensional tools measure only behavioral or physiologic parameters, but not both. The Neonatal Facial Coding System (NFCS) (Grunau & Craig, 1987) is an example of a unidimensional tool, and the one that was used in this study for coding infant pain in response to the heelstick. The NFCS, designed by Grunau and Craig (1987) is an adaptation of the Facial Action Coding System (FACS) by Ekman and Friesen (1978) that describes discrete facial movements. The NFCS is based upon a number of different facial expressions consisting of facial brow bulge, eye squeeze, naso-labial furrow, open lips, vertical mouth stretch, horizontal mouth stretch, lip purse (the lips appear as if an “OO” sound is being pronounced), a taut tongue (characterized by a cupped tongue with sharp tensed edges), tongue protrusion, and chin quiver (Grunau & Craig, 1987, 1990).

Change in facial activity is the most consistent indicator of pain across age groups. Studies on term and preterm neonates
have demonstrated significant differences in behavioral responses between painful and non-painful events, thus suggesting support for the specificity of facial activity measures as an indicator of pain (Craig, Whitfield, Grunau, Linton, & Hadjistavropoulos, 1993; Grunau & Craig, 1987; Rushforth & Levene, 1994; Grunau & Craig, 1990; Stevens, Johnston, & Horton, 1994). As a result, the NFCS has been used to discriminate between the infant’s response to tissue-insult and non-tissue-insult situations and/or procedures (Stevens & Johnston, 1994; Stevens, Johnston, & Horton, 1994; Johnston et al., 1995; Craig et al., 1993; Johnston, Stevens, Craig, & Grunau, 1993). Using the NFCS has demonstrated specificity to a painful event with increases in facial activity as is demonstrated with facial activity measurements or increased score with a facial pain assessment tool such as the NFCS (Ballantyne et al., 1999; Duhn & Medves, 2004).

The NFCS has established face and content validity based on the comprehensive means of development and expert review by its authors (Abu-Saad et al., 1998; Grunau & Craig, 1987). The NFCS has been used to study pain responses of premature infants and to discriminate between tissue-insult and non-tissue-insult situations (Stevens et al., 1996; Abu-Saad et al., 1998). Craig et al. (1993) compared the NFCS with the Facial Action Coding System (FACS) and the Pearson correlation coefficient was .89
indicating convergent validity (Steven et al., 1996; Abu-Saad et al., 1998). Inter- and Intrarater reliability have been consistently reported above 0.85 (Cohen’s kappa) (Stevens et al., 1996, Abu-Saad et al., 1998). The NFCS shows excellent ability to discriminate developmental and situational variation in a unidimensional approach to assessing pain. The NFCS is sensitive to change in pain intensity and thus has utility for evaluating pain-relieving interventions (Stevens et al., 1996). Despite these attributes, the NFCS as been shown to require intensive labor (extensive training and extensive time to code) by experienced coders for scoring (Steven et al., 1996; Abu-Saad et al., 1998). Therefore, with the exception of one study where the NFCS was shown to be reliable for bedside facial coding (Rushforth & Levene, 1994), it has been primarily limited to research (Stevens et al., 1996; Abu-Saad et al., 1998).

Premature Infant Pain Profile (PIPP)

The Premature Infant Pain Profile (PIPP) was developed by Stevens et al. (1996) to assess pain specifically in premature infants. The PIPP is considered a multidimensional tool because it codes for behavioral responses (brow bulge, eye squeeze, and naso-labial furrow), physiologic responses (heart rate and oxygen saturation), and contextual (gestational age and behavioral state) (Steven et al., 1996; Abu-Saad et al., 1998). Multiple other physiologic and behavioral responses were
originally considered for inclusion in the PIPP tool, but the goal was to create a tool that would be useful for both research and clinical application. This led to the deletion of many indicators from the PIPP pain tool (Stevens et al., 1996).

Three of the behavioral indicators used in the NFCS (lip purse, tongue protrusion, and chin quiver) were eliminated as they occurred almost exclusively in non-pain situations (Stevens & Johnston, 1994; Craig et al., 1993).

Each indicator is scored on a 4-point scale (score of 0 to 3). Younger infants can reach a maximum PIPP score of 21, while older infants may attain a maximum score of 18. For all age groups, a total score of 6 or less generally indicates minimal or no pain, a score of 7 to 12 indicates mild pain, and scores greater than 12 suggest moderate to severe pain (Stevens et al., 1996).

The PIPP was used in three different groups to establish construct validity. Internal consistency was evaluated and established using Cronbach’s alpha and ranged from 0.76 for eye squeeze (0.74 brow bulge, 0.72 naso-labial furrow, 0.66 oxygen saturation, and 0.64 heart rate) to 0.59 for behavioral state (Steven et al, 1996). These coefficients were in the moderate range of strength of correlation. This may reflect the limited relationship between the physiological, behavioral, and contextual factors within the tool. However, the standardized
item alpha for the six items was 0.71, suggesting that the measure demonstrates acceptable internal consistency (Stevens et al., 1996).

To establish construct validity of a tool, it should be used in extreme situations or with two extremely different groups (Streiner & Norman, 1989). To determine PIPP scores in two extreme situations, the PIPP was used to code for infants responses to a painful (heelstick) and a non-painful (handling) situation. The mean total PIPP score for the pain situation was 12.9 (SD=3.4) and for the non-pain situation 6.0 (SD=2.7). These scores were significantly different (paired $t=12.24$, two-tailed $p<0.0001$, and Mann-Whitney $U=765.5$, $p<0.00001$) suggested that the PIPP was accurately discriminating between a painful and a non-painful situation and establishing construct validity (Stevens et al., 1996; Ballantyne et al., 1999; Duhn & Medves, 2004).

Use of the PIPP in clinical practice was also determined by Ballantyne et al. (1999), in which PIPP scores from raters at the bedside were compared to independent ratings from trained coders using videotape of three separate sessions. There was a significant difference between sessions ($P<.001$) indicating statistical significance and supporting the construct validity of the measure but with no significant difference between the
raters suggesting the measure’s clinical utility (Abu-Saad et al., 1998; Stevens et al., 1996).

The moderate internal consistency of the PIPP suggests that the indicators (physiologic, behavioral, and contextual) may be measuring different components of the same phenomenon and are not highly correlated (Stevens et al., 1996). This finding is consistent with other investigations (Gunnar, 1992; Stevens & Johnston, 1994; Stevens, Johnston, & Horton, 1994; Johnston et al., 1995) which demonstrates that physiological and behavioral measures of pain in infants, when assessed simultaneously, were not highly correlated. Results of these studies suggest and provide reasonable justification for utilizing a multidimensional approach when assessing the infant’s response to a pain producing procedure since pain is a multidimensional phenomenon (Stevens et al., 1996; Duhn & Medves, 2004; Ballantyne et al., 1999).

Summary

In conclusion, this review focused on the Levine’s theory of energy conservation, the physiology of pain in the premature neonate, and a review of the pain assessment tools that was used to code the pain responses in the 20 randomly chosen premature infants. Levine’s model of energy conservation was presented. This model was presented as the theoretical framework for the design of this study. Furthermore, Levine’s model was used to
describe the importance of energy conservation for this vulnerable premature infant population.

Research is now available that shows this infant population is not only capable of experiencing pain, but is often hypersensitive to painful stimuli as a result of the infants underdeveloped nervous and endocrine systems. Because the NICU is an environment that subjects the premature infant to a host of invasive medical procedure, a rapid detection of the infant’s signs and symptoms of pain is imperative to the growth of the premature neonate.

While pain assessment tools are available, little research has been conducted to assess the correlation between the various pain assessment tools. This study was conducted to determine if a positive correlation exists between the PIPP and the NFCS pain assessment tools.
CHAPTER III

Method

The purpose of this study is to determine the correlation between pain tool scores on the Neonatal Facial Coding System (NFCS) with scores on the Premature Infant Pain Profile (PIPP). The design of the study, the sample selection, sample size, and inclusion and exclusion criteria are described in this chapter. Materials for the study, data collection procedures, limitations, and data analysis will also be discussed. The chapter will conclude with a summary of the contents.

Design

This research used a descriptive correlational design to determine if a relationship exists between the PIPP and the NFCS. A descriptive correlation design is used to examine the relationship that exists in a situation without controlling or manipulating the situation (Burns & Grove, 2001).

The design of this study was based on the original study by Evans, McCartney, and Lawhon (2002). A sample of 81 infants was recruited from the original study (Evans et al., 2002). In the original study, 344 heelsticks were performed under videotape surveillance. From the videotapes, the PIPP pain assessment scale was used to code the infant’s response to the heelstick. The data compiled from the pain response by each infant was then
entered into a database. The data obtained from observing the same videotapes and coding the infant’s response to the heelstick using the NFCS pain assessment tool for this study was then entered into this same database. Descriptive and correlation statistics were then generated from this updated database.

Subjects

Setting

This study was conducted at the Medical College of Ohio in the office of the principle investigator (Dr. Jane Evans).

Sample

A convenience sample was recruited from the original study (Evans et al., 2002) for this research study. This study included 20 subjects. Selection for this study was accomplished by placing a number representative of each infant into a hat and randomly drawing five numbers. This process was repeated for each of the four gestational age groups {Group 1 (less than 28 weeks gestational age), Group 2 (28-30 weeks gestational age), Group 3 (31-33 weeks gestational age), and Group 4 (34-36 weeks gestational age)} resulting in the total of twenty subjects for this study. In this group of 20 infants, a total of 83 heelsticks were performed. Eleven heelstick were discarded due to the presence of UV masks and the inability to code the infants using the PIPP in the original study. As a result, for
this study 72 reactions to the heelsticks were coded using the NFCS.

Inclusion Criteria

For this study, the inclusion criteria are those infants who had heelsticks coded from 23-36 weeks gestational age. Only those twenty infants randomly selected, as outlined previously, were included in this study.

Exclusion Criteria

For this study any infant which were excluded from this study included: infants for which there was not a videotape of the heelstick procedure; neonates not included in the original study (Evans et al., 2002); neonates who were younger than 23 weeks gestational age and older than 36 weeks gestational age; those infants not randomly selected by the sample selection process outlined above; and those 11 heelsticks where the infant was wearing a UV mask.

Materials

The Premature Infant Pain Profile Scale (PIPP) was developed by Stevens, Johnston, Petryshen, & Taddio (1996) to assess pain specifically in the premature infant. As indicated previously, in the original study, the PIPP was the pain assessment tool used to code the infant’s pain following the heelstick procedure.
The PIPP is a multidimensional scale consisting of three different groups of pain indicators: behavioral (brow bulge, eye squeeze, and naso-labial furrow), physiological response (heart rate and oxygen saturation), and contextual (gestational age and behavioral state) (Stevens et al., 1996).

The PIPP yields ordinal levels of measurement with total scores ranging from 0-21 with each of the seven indicators scored on a four point scale. More premature infants may obtain the maximum score of 21, whereas more mature infants may obtain a maximum score of 18. For each of the four age groups defined in this study, a total score of 6 or less generally indicates little or no pain, whereas scores totaling 12 or greater are considered to be more indicative of moderate to more severe pain (Stevens et al., 1996).

Internal consistency was evaluated and established using Cronbach’s alpha and ranged from 0.76 for eye squeeze to 0.59 for behavioral state. Use of the PIPP in clinical practice was also determined by Ballantyne et al (1999), in which PIPP scores from raters at the bedside were compared to independent ratings from trained coders using videotape of three separate sessions. There was a significant difference between sessions (P<.001) indicating statistical significance and supporting the construct validity of the measure but with no significant difference between the raters suggesting the measure’s clinical utility.
(Abu-Saad et al., 1998; Duhn & Medves, 2004). There has been more validity and reliability testing of the PIPP than any other measure of pain in infants (Duhn & Medves, 2004).

The Neonatal Facial Coding System (NFCS) is based upon a number of different facial expressions consisting of facial brow bulge, eye squeeze, naso-labial furrow, open lips, vertical mouth stretch, horizontal mouth stretch, lip purse (the lips appear as if an "OO" sound is being pronounced), a taut tongue (characterized by a cupped tongue with sharp tensed edges), tongue protrusion, and chin quiver (Grunau & Craig, 1990).

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response to heelstick was compared in the same infants across 8 weeks of development, infants demonstrated increasingly more behavioral responses as they matured. In like manner the NFCS has also been shown to be sensitive to painful and non-painful situations (Grunau & Craig, 1987; Craig et al., 1993; Duhn & Medves, 2004), to pain intensity (Grunau and Craig, 1987), and thus has utility for evaluating pain-relieving interventions (Stevens et al., 1996).

Despite these attributes, the NFCS has been used very little in the clinical setting because it requires intensive labor by experienced coders making this tool less feasible (Abu-Saad, Bours, Stevens, & Hamers, 1998). As a result, the NFCS has been used more in research (Steven et al, 1996; Abu-Saad et al., 1998).

Data Collection

As discussed previously, heelsticks were performed, and captured on video on the original 81 infants recruited by Evans et al. (2002) for that original study. In that original study, each heelstick was coded using the PIPP pain assessment tool. A total of 344 heelstick scores were obtained, using the PIPP pain assessment tool, from the original 81 infants. The scores were then entered into a database.

For this study, these same videotapes, and therefore the same heelsticks, were reviewed, only this time, only 20 infants
were included and pain was coded using the NFCS pain assessment tool. Pain scores were determined on five infants from each of the four gestational age groups. This led to a total of 20 subjects randomly selected from the original participants. From this sample of 20, 72 heelsticks were observed on videotape and coded using the NFCS. These scores were then entered into the database and statistical analyses were performed to determine the correlation between the PIPP and NFCS pain assessment tools.

Control for Threats to Internal and External Validity

A potential threat to internal validity could potentially be rater bias to scoring the infants response to pain. A solution to this would be to have a second individual score each of the heelsticks. A certain degree of consistency would be needed for acceptance of the heelstick for inclusion as data.

A potential threat to the external validity is that all videotapes are from the same hospital. As a result, the generalizability of the study is limited.

Assumptions

This study assumes that premature neonates do feel pain, and the observed physiologic and behavioral responses which are being coded with the pain assessment tools are responses to that perceived pain. The heelstick was the method being employed to initiate the pain response, and the assumption was made that this is a painful action which does elicit the physiological
nociception pathways by way of tissue damage. Finally, an assumption was made that all PIPP scores obtained in the original study (Evan et al., 2002) were accurate.

Limitations

This study consisted of a random sample (n=20), selected from the original convenience sample (n=81). This sample size is small and does limit the generalizability of the study to the population. Second, various individuals carried out the heelstick procedure. This variation could have led to possible inconsistencies in the procedural protocol which could have affected the results obtained from this study. Third, the duration the heelsticks were observed may not have been adequate enough to completely code the entire response by the infant. It is conceivable that a response could have been delayed enough that this coder missed that response which could have skewed the results for this study. Fourth, the use of the videotape itself was a limitation to this study. This single view often made observing the response of the infant difficult for the coder. In many videotapes, there was a substantial glare on the screen which made observation of the infant’s response to the heelstick very difficult. Finally, many of the infants included in this sample were either intubated or were wearing CPAP masks. Because the NFCS only codes facial responses, these devices often made observing the infant’s mouth and naso-labial area
very difficult if not impossible. As a result, many of these infants did not receive positive marks for responses that may have been expressed with their mouths. This likely resulted in lower NFCS scores for those infants who had those devices on their face.

Data Analysis

To answer the research questions for this study, scores obtained from the PIPP and the NFCS were analyzed using descriptive statistics, including means and standard deviations, and correlation statistics. Both Pearson’s product moment correlation and multiple regression techniques were used to determine correlation amongst the two pain assessment tools. For this study, alpha was set at 0.05. The research questions answered by these statistical methods included:

Question 1- Does a correlation exist between the PIPP and the NFCS pain tools for determining pain in a premature neonate following heelstick?

Question 2- What is the range of scores for heelsticks measured by the PIPP and NFCS pain assessment tools?

Summary

This chapter described the methodology for a correlation descriptive study on the cues of pain as outlined by the PIPP and NFCS pain assessment tools with the purpose of examining the effectiveness of assessing pain when using the PIPP and NFCS
pain assessment tools. The study’s design, subjects, materials, and instruments were described as were controls for external and internal validity. The data collection process was presented. Finally, the method of data analysis and inferential statistics which were used to determine statistical significance between the PIPP and the NFCS was presented.
CHAPTER IV

Results

This chapter presents the results for the descriptive and correlation statistics obtained using the Premature Infant Pain Profile (PIPP) and the Neonatal Facial Coding System (NFCS) for the sample used in this study. Included is the demographic information for the sample as well as the means and standard deviations for the gestational ages and the scores obtained with both the PIPP and the NFCS pain tools. Next descriptive and correlation statistics for the scores obtained from the PIPP (from the original study by Evans et al. (2002) and the scores obtained from the NFCS will be presented. Finally, a summary will be provided to briefly review this chapter.

Sample

The final sample for this study consisted of 20 infants, five from each of the four gestational age groups. Each of the 20 infants was recruited from the original study (Evans et al., 2002). Five infants were randomly selected from each of the following gestational age groups; Group 1 (less than 28 weeks gestational age), Group 2 (28-30 weeks gestational age), Group 3 (31-33 weeks gestational age), and Group 4 (34-36 weeks gestational age). In the original study (Evans et al., 2002) multiple heelsticks were performed on each of the original 81
infants. From the 20 infants randomly selected for this study, a total of 72 heelsticks were coded using NFCS pain tools for comparison with scores obtained using the PIPP pain tool in the original study.

Within the sample of 20 infants, there were 14 males (70%) and 6 females (30%). Subjects ranged in gestational age from 24 weeks to 35 weeks with a mean age of 30.30 weeks, \( SD=3.57 \). The subjects consisted of 14(70%) Caucasian, 5(25%) African American, and 1(5%) being of either Mexican or Asian decent.

Findings for Research Question #1

Research question #1 asked if a correlation existed between the PIPP and the NFCS. The results for the correlation statistics are present in the Table 1 (whole sample, \( n=20 \) infants) and Table 2 (each gestational age group, \( n=5 \) infants).

Table 1: Correlation Statistics for Whole Sample. Statistical Significance at the 0.05 level. (\( N= \) # of heelsticks coded)

<table>
<thead>
<tr>
<th></th>
<th>PIPP</th>
<th>NFCS</th>
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<tr>
<td>All Age Groups</td>
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<tr>
<td>PIPP</td>
<td>Pearson Correlation 1 .632</td>
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<td>Sig. (2-tailed)</td>
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<tr>
<td>N</td>
<td>72</td>
<td>72</td>
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<tr>
<td>NFCS</td>
<td>Pearson Correlation .632 1</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<tr>
<td>N</td>
<td>72</td>
<td>72</td>
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</table>
Table 2: Correlation Statistics for Each Individual Age Group. Groups consist of 5 infants. Statistical significance at the 0.05 level. (N= # of heelsticks coded for each individual group).

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<tr>
<th></th>
<th>PIPP</th>
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<th>NFCS</th>
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<tr>
<td><strong>Group 1</strong></td>
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<td>&lt; 28 weeks</td>
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<tr>
<td>PIPP</td>
<td>Pearson Correlation</td>
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<td>.589</td>
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<td>Sig. (2-tailed)</td>
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<tr>
<td>NFCS</td>
<td>Pearson Correlation</td>
<td>.589</td>
<td>1</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<tr>
<td><strong>Group 2</strong></td>
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<tr>
<td>28-30 wks</td>
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<tr>
<td>PIPP</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.192</td>
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<td>Sig. (2-tailed)</td>
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<td>N</td>
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<td>16</td>
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<tr>
<td>NFCS</td>
<td>Pearson Correlation</td>
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<td>Sig. (2-tailed)</td>
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<td><strong>Group 3</strong></td>
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<td>31-33 wks</td>
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<tr>
<td>PIPP</td>
<td>Pearson Correlation</td>
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<td>Sig. (2-tailed)</td>
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<tr>
<td>NFCS</td>
<td>Pearson Correlation</td>
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<td>Sig. (2-tailed)</td>
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<td><strong>Group 4</strong></td>
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<td>34-36 wks</td>
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<tr>
<td>PIPP</td>
<td>Pearson Correlation</td>
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<td>Sig. (2-tailed)</td>
<td>.013</td>
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<td>12</td>
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<tr>
<td>NFCS</td>
<td>Pearson Correlation</td>
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<td>Sig. (2-tailed)</td>
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Correlation Statistics for All Gestational Age Groups

Correlation statistics were run to evaluate the relationship between the PIPP and NFCS. For the sample of 20 infants and a combined 72 heelsticks, the results confirmed statistical significance ($p=.000$) with a moderately strong relationship ($r=.632$) between the PIPP and the NFCS.

Correlation Statistics for Group 1 (less than 28 weeks)

From the five randomly selected infants in Group 1, 25 heelsticks were coded. The correlation statistics for this group demonstrated statistical significance ($p=.002$) with a moderate strength relationship ($r=.589$) between the PIPP and NFCS pain tools.

Correlation Statistics for Group 2 (28-30 weeks)

From the five randomly selected infants in Group 2, 16 heelsticks were coded. The correlation statistics for this group did not demonstrate statistical significance ($p=.475$). In like manner, the relationship between the PIPP and the NFCS for Group 2 was very weak ($r=.192$).

Correlation Statistics for Group 3 (31-33 weeks)

From the five randomly selected infants in Group 3, 19 heelsticks were coded. The correlation statistics for this group demonstrated statistical significance ($p=.016$) with a moderate strength relationship ($r=.545$) between the PIPP and NFCS pain tools.
Correlation Statistics for Group 4 (34-36 weeks)

From the five randomly selected infants in Group 4, 12 heelsticks were coded. The correlation statistics for this group demonstrated statistical significance ($p=.013$) with a moderately strong relationship ($r=.689$) between the PIPP and NFCS pain tools.

Findings for Research Question #2

Research question #2 asked for the ranges, means, and standard deviations for the scores obtained when coding the heelsticks with the PIPP and NFCS pain assessment tools. The results for question #2 are presented in Tables 3 and 4 on the following page.

Means and Standard Deviations for All Gestational Age Groups

From the sample of twenty infants (five from each of the four gestational age groups), a total of 72 heelsticks ($n=72$) were coded using the PIPP and the NFCS pain assessment tools. The minimum score obtained using the PIPP pain assessment tool was 2 and the maximum was 18. The mean PIPP score for the coded heelsticks ($n=72$) was 9.29, $SD=4.02$. The minimum score using the NFCS pain assessment tool was 0 and the maximum was 10 (coding was accomplished using a 0-10 scale; 0 being no observed pain response and 10 being maximum pain response). The mean NFCS score for the coded heelsticks ($n=72$) was 4.71, $SD=3.44$. 
### Table 3: Descriptive Statistics for Scores from All Age Groups

<table>
<thead>
<tr>
<th>Heelstick(#)</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPP</td>
<td>72</td>
<td>2</td>
<td>18</td>
<td>9.29</td>
</tr>
<tr>
<td>NFCS</td>
<td>72</td>
<td>0</td>
<td>10</td>
<td>4.41</td>
</tr>
</tbody>
</table>

### Table 4: Descriptive Statistics for Scores from Each Individual Age Group

<table>
<thead>
<tr>
<th></th>
<th>Heelstick (#)</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong>&lt; 28 wks</td>
<td>PIPP</td>
<td>25</td>
<td>3</td>
<td>18</td>
<td>8.36</td>
</tr>
<tr>
<td></td>
<td>NFCS</td>
<td>25</td>
<td>0</td>
<td>10</td>
<td>3.64</td>
</tr>
<tr>
<td><strong>Group 2</strong>20-30 wks</td>
<td>PIPP</td>
<td>16</td>
<td>3</td>
<td>10</td>
<td>6.81</td>
</tr>
<tr>
<td></td>
<td>NFCS</td>
<td>16</td>
<td>0</td>
<td>9</td>
<td>3.59</td>
</tr>
<tr>
<td><strong>Group 3</strong>31-33 wks</td>
<td>PIPP</td>
<td>19</td>
<td>3</td>
<td>17</td>
<td>11.79</td>
</tr>
<tr>
<td></td>
<td>NFCS</td>
<td>19</td>
<td>1</td>
<td>10</td>
<td>6.58</td>
</tr>
<tr>
<td><strong>Group 4</strong>33-36 wks</td>
<td>PIPP</td>
<td>12</td>
<td>2</td>
<td>17</td>
<td>10.58</td>
</tr>
<tr>
<td></td>
<td>NFCS</td>
<td>12</td>
<td>0</td>
<td>10</td>
<td>5.58</td>
</tr>
</tbody>
</table>

**Means and Standard Deviations for Group 1 (less than 28 weeks)**

A total of 25 heelsticks were coded for this gestational age group. Coding using the PIPP resulted in a minimum score of 3 and maximum score of 18. The mean score was 8.36, SD=3.57. Coding for this age group using the NFCS resulted in a minimum
score of 0 and a maximum score of 10. The mean score was 3.64, $SD=3.21$.

**Means and Standard Deviations for Group 2 (28-30 weeks)**

A total of 16 heelsticks were coded for this gestational age group. Coding using the PIPP resulted in a minimum score of 3 and maximum score of 10. The mean score was 6.81, $SD=1.94$. Coding for this age group using the NFCS resulted in a minimum score of 0 and a maximum score of 9. The mean score was 3.59, $SD=2.50$.

**Means and Standard Deviations for Group 3 (31-33 weeks)**

A total of 19 heelsticks were coded for this gestational age group. Coding using the PIPP resulted in a minimum score of 3 and maximum score of 17. The mean score was 11.79, $SD=3.78$. Coding for this age group using the NFCS resulted in a minimum score of 1 and a maximum score of 10. The mean score was 6.58, $SD=2.81$.

**Means and Standard Deviations for Group 4 (34-36 weeks)**

A total of 12 heelsticks were coded for this gestational age group. Coding using the PIPP resulted in a minimum score of 2 and maximum score of 17. The mean score was 10.58, $SD=4.96$. Coding for this age group using the NFCS resulted in a minimum score of 0 and a maximum score of 10. The mean score was 5.58, $SD=4.62$. 
Summary

This chapter provided an overview of the demographics of the sample used to answer the research questions. Correlation statistics were used to test the relationship between the PIPP and NFCS pain assessment tools. The results indicated a statistically significant relationship between these pain tools \((p=.000)\), with a Pearson correlation coefficient of \(.632\), indicating a moderately strong relationship between the PIPP and the NFCS.
CHAPTER V
Discussion

This chapter contains a discussion of the findings for this study using the PIPP and the NFCS for detecting the infant response to pain following a heelstick. The study findings are explained in comparison to those findings found in the literature review. The findings are also explained in terms of the theoretical framework, Levine’s theory of Energy Conservation (Levine, 1969, 1989). Finally, conclusions, limitations, implications for nursing theory, nursing practice, nursing education, nursing administration, and directions for future research are presented.

Findings for Research Question #1

Research question #1 asked if a statistically significant correlation existed between the PIPP and the NFCS for detecting pain in the premature neonate following a heelstick. The findings from the Pearson product moment correlation analysis indicated a statistically significant correlation between the PIPP and the NFCS for detecting pain in the neonate. The Pearson product moment correlation indicated a moderately strong correlation (r=.632).

This data suggests that the PIPP and the NFCS similarly identified the intensity with which the infants responded to the
heelstick. The data suggests that if an infant’s response was weak, both tools coded with a low score, indicating little or no pain; if the infant’s response to the heelstick was strong, both tools coded with a higher score indicating moderate to severe pain.

Pain is a multidimensional phenomenon (Stevens et al., 1996; Ballantyne et al., 1999; Anand, 1999), requiring that the pain tool also have multidimensional design (Stevens et al., 1996; Duhn & Medves, 2004). Studies by Gunner (1992), Stevens et al. (1994), Stevens and Johnston (1994), Johnston et al. (1995) demonstrated that physiological and behavioral measures of pain in infants, when assessed simultaneously, were not highly correlated. The data in this study contradicts this finding. This study’s data suggests that despite the unidimensional behavioral approach of the NFCS, it does code pain with a similar score in relationship to the scoring of the PIPP tool. The NFCS has been shown through research to be a very reliable and valid tool for assessing the preterm infant’s pain despite its unidimensional design (Grunau & Craig, 1987; Abu-Saad et al., 1998; Grunau & Craig, 1990). The findings from this study suggest that the NFCS might be considered equal with the PIPP for scoring pain in the premature infant.

Next, facial expressions of neonates have been shown to be distinct for painful and non-painful situations to the point
when coding facial expressions, researchers have been able to
discriminate between tissue-insult and non-tissue-insult
situations (Grunau & Craig, 1987; Stevens et al., 1996; Abu-Saad
et al., 1998). In the development of the PIPP tool, Stevens et
al. (1996) eliminated three facial actions (lip purse, tongue
protrusion, and chin quiver) stating that these facial actions
occurred almost exclusively in non-pain situations. This
finding from their previous studies also contradicts some of the
findings from this study. In many of the infant’s responses to
the heelsticks, these variables were coded indicating not only
their presence, but validating the initial findings of Grunau
and Craig (1987) that these facial responses are indicators of
pain.

To further validate the significant findings between the
PIPP and the NFCS, correlation statistics were run on each of
the four gestational age groups. The results from these
statistical analyses further validated the findings that a
statistically significant correlation exists between the PIPP
and the NFCS.

The $p$ values and Pearson correlation coefficient obtained
for each gestational age group were as follows: Group 1 $p=.002,$
r=.589; Group 2 $p=.475,$ $r=.192;$ Group 3 $p=.016,$ $r=.545;$ and
Group 4 $p=.013,$ $r=.689.$
This data indicates that all groups, with the exception of Group 2, had statistically significant results. These results confirm the previous findings that both the PIPP (Stevens et al., 1996) and the NFCS (Grunau & Craig, 1990) are effective tools for the detection and coding of infant pain. Furthermore, these findings further validate the ability of both the PIPP and the NFCS to code pain in the premature neonate in a similar manner.

Finally, this data validates the findings from previous research (Brooks, 1999; Glover et al., 2000; Puchalski et al., 2002; Evans, 2002; Lindh et al., 1987; Johnston et al., 1995) that the premature infant has the ability to feel pain. In addition, this study also confirms the previous findings that pain is expressed and detected whether the pain response is physiologic (Brooks, 1999; Franck and Miaskowski, 1997; Glover and Fisk, 2000; Evans, 2002) and/or behavioral (Puchalski and Hummel, 2002; Grunau and Craig, 1990).

Despite the lack of statistical significance for Group 2, it is still important to note the statistical significance obtained from Group 1. This confirms that the pain response is present and can be detected similarly with the PIPP and the NFCS pain tools and at very premature gestational ages. Furthermore, it is important to note the strength of the statistical significance obtained from Group 4. The statistical analysis of
Group 4 resulted in the strongest Pearson correlation \((r = .689)\) of all statistical analysis conducted, including that obtained for the entire sample of 20 infants \((r = .632)\). This finding may also further validate the conclusion drawn previously, and confirm the research conducted by Holsti (2004) that the strength of the response to pain is more accurately detected by the pain scales at later gestational ages as was also indicated by the mean scores from the pain scales for each gestational age group. Again, this is likely the result of the increased neural development within the infant’s nervous system at later gestational ages. This supports the previous findings that infants at later gestational ages can respond to a painful stimulus, such as the heelstick, with a much more integrated and stronger response, whereas infants at earlier gestational ages have responses of much smaller magnitude, particularly at the earliest gestational ages (Johnston and Stevens, 1996; Craig et al., 1993; Holsti, 2004).

Findings for Research Question #2

The second research question asked for a comparison between the scores obtained from both pain scales in relationship to the means and standard deviations. The results demonstrate a very similar score in means (9.29 for the PIPP and 4.41 for the NFCS) between the two scales in relationship to each tools minimum and maximum scores (2-18 for the PIPP and 0-10 for the NFCS).
The mean score for both the NFCS and PIPP was within the standard deviation of being right in the middle of the scale. This alone suggests that the two scales comparably coded the infant’s response to the heelstick.

Furthermore, the same observation can be concluded by studying the means and standard deviation of each gestational age group. Both Group 1 and Group 2 had mean scores below the midpoint of the respective scales (a score of 9 on the PIPP and a 5 on the NFCS), whereas, Group 3 and Group 4 had mean scores above the midpoint for each of the respective pain scales.

Not only were these results significant, but these results also support the literature. As the infants gestational age increases, the development of the nervous system continues to mature resulting in an increasing number of functioning neurons and a more mature endocrine system, each of which is necessary to modulate the pain response (Jorgensen, 1999; Fitzgerald, 1995; Anand, 1999). Sensory stimulation of the young infant often produces a variety of responses, and at times, no physical response to pain is observed (Anand, 1999). For this reason, one would expect the coding from both scales to result in lower mean scores for the more premature infants, whereas those infants more physiologically developed would possess greater neural capabilities to express a more complete pain response resulting in a higher score from both pain scales. The results
obtained in this study support this expectation as well as the literature review and the findings from previous research.

Last with respect to the theoretical framework, this research supports Levine’s model for the conservation of energy. As stated previously, the data supports the premature infant’s ability to increase its pain response with increased growth. Because the premature infant’s energy reserve is minimal, assessment of pain and action to eliminate its pain is vital to the conservation of the infant’s energy and the promotion of the infant’s wholeness. This is the responsibility of the clinician who is caring for the premature infant; to promote an environment that will facilitate growth through energy conservation.

Conclusions

Based on the analysis of the data obtained from the correlation statistics between the PIPP and the NFCS, several conclusions can be drawn. First, the data supports the research (Craig et al., 1993; Anand, 1999) that premature infants feel pain. Both the PIPP and NFCS have been shown, through research, to be reliable and valid for detecting infant pain (Grunau & Craig, 1987; Grunau & Craig, 1990; Stevens et al., 1996). The results from this study, as a result of the scores obtained using the PIPP and the NFCS, confirm the infant’s ability to perceive the heelstick as painful. Second, because the tools
code for pain, a conclusion can be made that the heelstick is painful since this procedure initiated a change in physical and behavioral parameters form the baseline established by the tools design. Third, because of the statistical significant correlation, it can be concluded that there is a strong positive correlation which establishes convergent validity between the PIPP and NFCS pain tools.

Finally, the results from Group 2 did not support the hypothesis of the study. Because of the lack of correlation and the diminished mean scores obtained from both PIPP and the NFCS, further investigation is warranted as to what was the cause for this data. Within this gestational age group, many of the infants were either intubated are had CPAP masks over their mouths and noses. It is also possible that these infants were sedated as a result of being intubated. These conditions would have lowered the ability of the infant to respond to the heelstick. Furthermore, the masks and intubation tubing was an obstacle for the coder as these devices limited the ability of the coder to make an accurate assessment of the facial response expressed during and following the heelstick procedure.

Limitations

There were several limitation encountered in the course of this study which must be acknowledged. First, the sample size used in this study was a small convenience sample (n=20)
obtained from the original study by Evans et al. (2002). From the sample of twenty, just 72 heelsticks were coded. This limited number of subjects resulted in a limited number of heelsticks which limits the generalizability of the results of this study to a larger population.

Second, there was not an established protocol for administration of the heelstick. This variability of technique could have altered the response by the infant leading to miscoding and faulty data.

Third, a very significant limitation to this study was the use of videotape used for coding the heelsticks. This method of coding the infant’s pain limited the coder to a single view of the infant. This limited the visual accuracy of the coder. Often the screen was either too dark and/or had too much glare which potentially led to inaccurate results.

Finally, many of the infants coded for this study were either intubated or were on CPAP machines. Because the NFCS only codes facial responses, this limited the ability of the coder to accurately code those facial components of the NFCS dealing with the mouth and naso-labial area. In addition, the respiratory equipment likely limited the infant’s facial expressions, especially if the infant were sedated while intubated. As a result, the response by the infant to the heelstick may have resulted in a lower pain score.
Implications for Nursing Theory

Levine’s Conservation of Energy theory (Levine, 1969, 1973, 1989) as a framework for this study was a valuable part of this study. Levine’s conservation model demonstrates the importance for conserving energy, especially in the neonate, where energy conservation is necessary for growth.

If pain goes unnoticed, or if the intensity of the infant’s pain is mistakenly minimized by inaccurate tools or inaccurate coding, the result is likely to be an infant who is expending more energy than it is conserving. Because of the numerous numbers of infants who will immediately begin their lives within the NICU, and therefore have to endure this taxing environment, it is imperative that Levine’s energy conservation principles be understood and practiced. This means having effective pain assessment tools for the clinician who cares for these fragile beings within the NICU. Positive nursing action in response to the infant’s expression of pain with the help of these effective pain assessment tools and knowledge of Levine’s energy conservation theory will result in better infant growth in the NICU.

Implications for Nursing Practice

There are several implications to nursing practice identified by this study. First, as was stated previously, this study confirms that the infant is capable of expressing pain.
This study also demonstrates that infants express pain in various ways, both behaviorally and physiologically as is evidenced by the scores obtained with both the PIPP (which detects behavioral and physiological changes in the infant), and the NFCS (which detects only facial behavioral changes in the infant). This is important to the clinician for several reasons. First, although using a single pain index may be easier for a clinician (Holsti, 2004), this allows the clinician to have several tools with which to determine the intensity of the infant pain, and therefore act accordingly, with either pharmacological or comforting techniques, to control the pain response.

Secondly, it allows the clinician the confidence that he/she has an effective tool for identifying infant pain. If the clinician thinks an infant is in pain but does not get a score indicating increased pain, the clinician would have another tool to confirm or contradict the first finding. The ability of the nurse to confirm or deny the first finding will only benefit the infant. This could mean medicating the infant for pain when it normally would not have been, or this could also help prevent over medicating the infant when the score confirms a limited pain response.
Implication for Nursing Education

Nurses are a vital component to the survival of the premature neonate while this tiny being lives in the NICU. As a result, nurses need to be educated about the consequences of inadequately identifying those indicators of the infant pain response. Hospital nurse educators and school nurse educators need to educate nurses on the physiology of pain in the neonate, the way in which neonate’s respond to a painful stimulus, the physiological and behavioral indicators of infant pain, and the correct choice of infant pain assessment tools. Nurses practicing in the NICU must have accurate, up to date information on this vulnerable population. Proper assessment of infant pain and an understanding of Levine’s energy conservation theory will help the nurse better ensure the survival of the premature neonate. With a better understanding of infant pain measurement comes the need for educating the nurse on the best methods of effectively minimizing and/or eliminating pain in the neonate. This, in turn, will facilitate the growth of the premature neonate.

Implication for Nursing Administration

Neonates have very limited energy reserves. Therefore it is imperative that their energy be conserved for those processes which facilitate growth. At the administrative level, a procedural protocol which is evidenced based should be developed
for common procedures, such as the heelstick, with the intention of minimizing pain in the premature neonate. In addition, comfort measures should be established to reduce stress associated with the NICU environment. Finally, nursing administration should mandate the use of research based pain assessment tools with the intention of lowering pain scores through educational sessions for all clinicians involved in the care of the premature neonate.

Recommendations for Further Research

The recommendations for further research in this population are many. First, there is a need for studies in which a more diverse group of infants are studied, both culturally and geographically. Second, additional research should be completed comparing each of the pain assessment tools against each other, not just against the PIPP. Third, additional studies should begin to investigate the individual variables which make up the pain tools. Future studies should investigate the correlation between each tool’s variables. From this research, a pain tool may be designed which contains all the necessary elements (behaviorally and physiologically) which best determines the response and the intensity of the premature infant’s pain. Finally, research into procedural protocols is necessary to establish the best methods for conducting the many painful procedures performed on the premature infant. This would limit
the pain inflicted on the neonate. This combined with the best
evidence based pain assessment tools would facilitate the
maintenance of the limited energy reserves the premature neonate
attempts to maintain.

Summary

In summary, this investigation into the correlation between
the PIPP and NFCS pain assessment tools yielded statistically
significant results. This research established convergent
validity between the PIPP and NFCS pain assessment tool.
Furthermore, this study established the NFCS as an effective
unidimensional premature infant pain assessment tool despite
multidimensional phenomenon of pain.

Limitations as they applied to this study were categorized
as related to sample size, design (secondary analysis), method
of data collection (videotape), and limited view of the infants
face as the result of accessory respiratory equipment.

Implications for nursing theory, nursing research, nursing
education, and nursing administration, as well as
recommendations for future research was proposed within the
framework of Levine’s theory of energy conservation.
References


## Appendix A
Premature Infant Pain Profile (PIPP) Tool

<table>
<thead>
<tr>
<th>Process</th>
<th>Indicator</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chart</td>
<td>Gestational Age</td>
<td>36 weeks and more</td>
<td>32-35 weeks, 6 days</td>
<td>28-31 weeks, 6 days</td>
<td>Less than 28 weeks</td>
<td></td>
</tr>
<tr>
<td>Observe infant 15 seconds</td>
<td>Behavioral State</td>
<td>Active/awake</td>
<td>Quit/awake</td>
<td>Active/sleep</td>
<td>Quit/sleep</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eyes open</td>
<td>Eyes closed</td>
<td>Eyes closed</td>
<td>Eyes closed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facial movements</td>
<td>Facial movements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen Saturation</td>
<td>Heart Rate Max</td>
<td>0-4 beats/min increase</td>
<td>5-14 beats/min increase</td>
<td>15-24 beats/min increase</td>
<td>25 beats/min or more increase</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-2.4% decrease</td>
<td>2.5-4.9% decrease</td>
<td>5.0-7.4% decrease</td>
<td>7.5% or more decrease</td>
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<td></td>
<td></td>
<td>Minimum</td>
<td>Moderate</td>
<td>Maximum</td>
<td></td>
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<td></td>
<td></td>
<td>Minimum 10-39% of time</td>
<td>Moderate 40-69% of time</td>
<td>Maximum 70% of time or more</td>
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<td></td>
<td></td>
<td>Minimum 10-39% of time</td>
<td>Minimum 10-39% of time</td>
<td>Maximum 70% of time or more</td>
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<tr>
<td></td>
<td></td>
<td>Maximum 70% of time or more</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td>None</td>
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<tr>
<td></td>
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<td>0-9% of time</td>
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</tr>
</tbody>
</table>
Scoring Method for the PIPP

1. Familiarize yourself with each indicator and how it is to be scored by looking at the measure.

2. Score gestational age from the chart before you begin.

3. Score behavioral state by observing the infant 15 seconds immediately before the event.

4. Record baseline heart rate and oxygen saturation.

5. Observe the infant for 30 seconds immediately following the event. You will have to look back and forth from the monitor to the baby’s face. Score physiological and facial action changes seen during that time and record immediately following the observation period.

6. Calculate the final score.
## Appendix B

**Neonatal Facial Coding System (NFCS) Tool**

<table>
<thead>
<tr>
<th></th>
<th>0 points</th>
<th>1 point</th>
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<tbody>
<tr>
<td><strong>Facial Brow Bulge</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Eye Squeeze</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Naso-Labial Furrow</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Open Lips</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Vertical Mouth Stretch</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Horizontal Mouth Stretch</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Lip Purse</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>(&quot;oo&quot; sound)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Taut Tongue</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>(cupped tongue)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tongue Protrusion</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Chin Quiver</strong></td>
<td>Absent</td>
<td>Present</td>
</tr>
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</table>

**Total Points:**

<table>
<thead>
<tr>
<th>Infant #:</th>
<th>Sex:</th>
<th>Race:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Gestational Age:</th>
<th>(weeks)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Birthweight:</th>
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Abstract

Shortly after birth, the premature infant enters into the intense environment, known as the neonatal intensive care unit (NICU), where this tiny being will be subjected to numerous medical and nursing procedures which will inflict pain. Previous research has well established that the premature infant has the physiologic capabilities to feel pain. As a result, the clinician must continually assess the neonate for signs of pain. Because the neonate has very little energy reserves, it is crucial that the infant conserve and use its energy for growth. Up to now, although clinicians have had numerous pain assessment tools to work with for assessing infant pain, very little research has been conducted which compares the pain tools against one another. Therefore, the purpose of this study was to investigate the correlation between the PIPP (a multidimensional) and the NFCS (a unidimensional) pain assessment tools. The data indicated that these tools are significantly correlated (p=.000, r=.632). Data such as this, and other which will follow, will give the clinician at the bedside the best means for assessing, treating, and even preventing unnecessary or prolong infant pain.